Calculating Costs of Switching to Alternative Surface Coating Systems Using an Online Tool http://cage.rti.org

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ABSTRACT

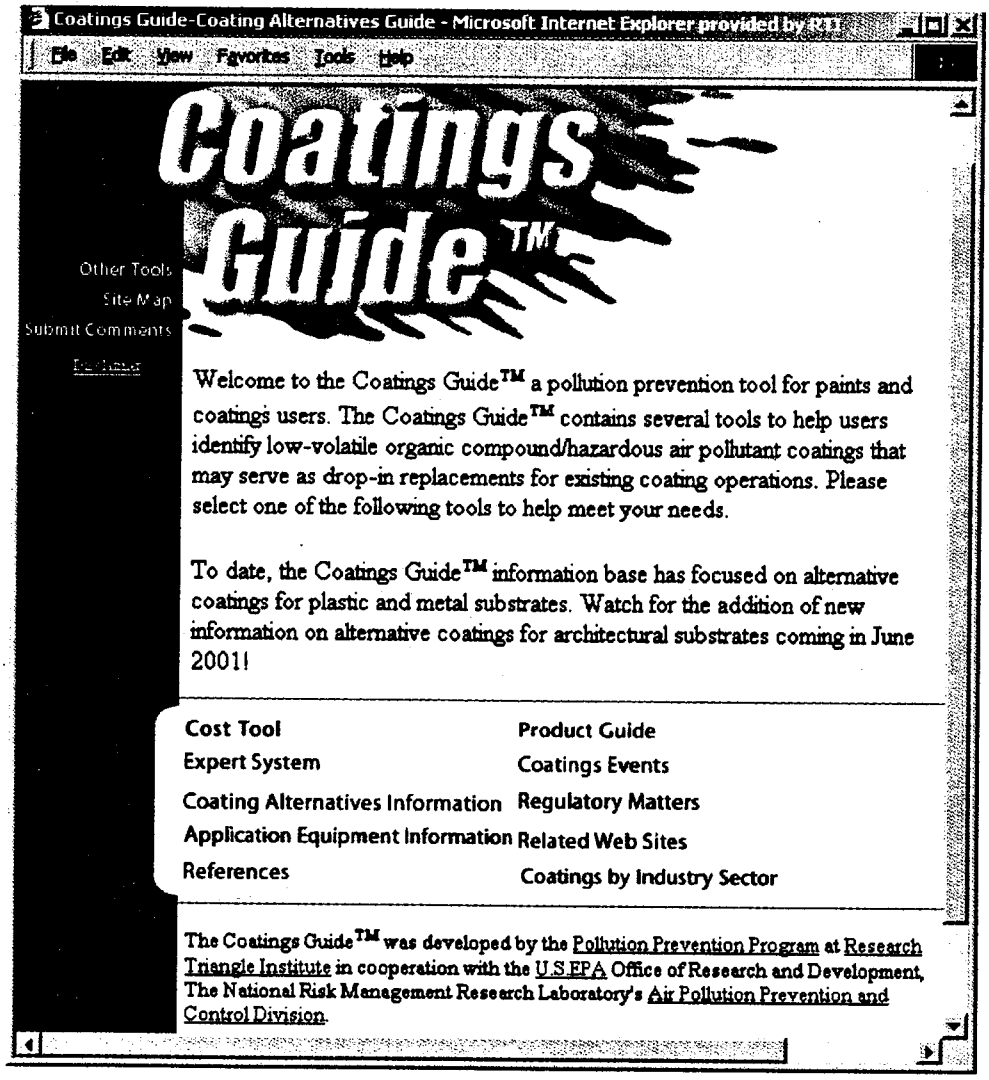
Regulatory pressures to reduce volatile organic compounds (VOCs) from surface-coating operations have resulted in an array of low-VOC coating options, such as water-borne or powder coatings, for a variety of end-user markets. Companies want to know how using these low-VOC coatings might benefit them and affect their equipment and annual operating costs.[1] A free Internet tool that identifies the full costs of alternative coating systems is now available. Users can analyze the costs involved in switching from a traditional solvent-borne coating to a low-VOC coating and compare two alternative systems to each other.

The Coatings Guide Cost Tool identifies the variables necessary to calculate capital and annual operating costs of coating processes. It helps companies evaluate the following costs: material, equipment, energy, labor and maintenance, waste management, emissions control, and permitting or compliance costs. Although other cost models leave out equipment costs and nontraditional costs, or lump them into general overhead costs, the Cost Tool addresses equipment costs in detail as well as other costs such as testing, training, and health and safety. Assessing these costs provides the user with a more complete picture of the true costs of switching from one coating system to another. This paper discusses an example to illustrate the functionality and use of the Coatings Guide Cost Tool.

INTRODUCTION

Research Triangle Institute has created several innovative pollution prevention (P2) support tools for environmental decision-making. One example of these tools is a Web-based tool for the coatings industry called the Coatings Guide (see Figure 1).[3] The Coatings Guide contains several P2 tools, including the Expert System, Coating Alternatives Information, the Product Guide, and Coatings by Industry Sector.[4,5] Perhaps the most useful Coatings Guide tool for justifying P2 investment is the Cost Tool, which can be used to evaluate costs of switching to a low-emitting coating technology.

Figure 1. The opening page of the Coatings Guide, which displays the pollution prevention tools that are available, including the Cost Tool, Expert System, Coating Alternatives Information, the Product Guide, and Coatings by Industry Sector.



The Cost Tool identifies the variables necessary to calculate annual and capital costs of various coating processes. The Cost Tool is based on the principles of environmental cost accounting[6] as an aspect of management accounting to help business managers make decisions about P2 activities. Investing in P2 may involve decisions about capital investments, process design, and performance evaluations.[7] The Cost Tool uses a full cost approach that could highlight potential cost savings to a private company that are due to P2 activities. The tool helps companies evaluate and itemize costs such as material, equipment, energy, labor and maintenance, and waste. In addition to itemizing costs, the Cost Tool can compare the costs of switching from one coating system to another. This tool includes 20 generic coating choices, including radiation-curable coatings, one- and two-component solvent-bornes and water-bornes, and solids.

Companies can use the Cost Tool to justify P2 investment in several ways. First, the Cost Tool offers a format of the data inputs that are necessary to determine the costs or savings involved in switching to a low-emitting coating. The provided format enables users to collect the necessary information for calculating costs. The format is also helpful when presenting cost information to the appropriate decision-makers.

Second, the Cost Tool directs the user to the types of costs and particular cost drivers that are critical to the particular scenario. For example, if a user wanted to switch from a solvent-borne to a water-borne coating using the same equipment setup, equipment costs would not be critical, but applied material costs would be if the water-borne coating cost more per gallon. However, waste costs might be considerably lower for the water-borne coating, depending on local waste disposal costs and the cost per gallon of paint. Using the Cost Tool would identify which particular costs would be affected by adopting a P2 activity such as switching to a lower emitting coating.

In addition to identifying cost drivers, the Cost Tool can compare two different coating types. The tool highlights relative differences between cost categories and can be used to show alternative scenarios. For instance, a user can use their current system as a baseline and compare it to alternative scenarios involving alternative coating technologies with varying applied material, equipment, or waste costs. In this way, the Cost Tool helps users determine how sensitive the total costs are to changes in particular cost categories.

COST TOOL DESCRIPTION

For users who want to evaluate the pros and cons of changing to a new coating type, the Cost Tool is a way to identify what costs may be involved. Users select their current coating system and a new system from 22 generic coating chemistries. Table 1 lists the coating technologies that can be compared using the Cost Tool, including solvent-bornes, water-bornes, powders, and miscellaneous coatings.

Table 1. Coating technologies that can be compared using the Coatings Guide Cost Tool.

Solvent-bornes	**Water-bornes**
Air/Force-Dried Acrylic Air/Force-Dried Epoxy Ester Air/Force-Dried Two-Component Epoxy Air/Force-Dried Two-Component Urethane Air/Force-Dried One-Component Urethane Air/Force-Dried Silicone Baked Alkyd Low-Solids Conventional	Air/Force-Dried Acrylic Latex Air/Force-Dried Acrylic Epoxy Air/Force-Dried Two-Component Epoxy Air/Force-Dried Urethane Dispersions Baked Alkyd, Modified Alkyd, Acrylic
Powders	**Miscellaneous**
Epoxy Epoxy-Polyester Hybrid Polyester Acrylic Fluorocarbon Urethane	100% Solids (Plastisols) Radiation-Cured Coatings Electrocoat

Categories of costs include applied material, equipment, energy, labor and maintenance, and non-traditional costs such as testing, training, and health and safety. Table 2 illustrates the major cost categories considered by the Cost Tool, as well as some of the variables required to calculate the total annual cost per square foot.

Table 2. Cost categories and variables considered in the Coatings Guide Cost Tool.

APPLIED MATERIALS Paint Cost, Percent Volume Solids, Dry Film Thickness, Specific Gravity, Transfer Efficiency, Application Method, Production Rate
ENERGY Energy Type, Energy Efficiency, Energy Cost, Incinerator Type, Outside, Plant & Bake Temperature
EQUIPMENT Purchased Equipment, Direct Installation, Indirect Installation, Capital Equipment, Overhead
LABOR AND MAINTENANCE Operating Hours per Year, Number of Employees, Employees' Wages, Maintenance Hours per Year
WASTE Cost of Filters, Cost to Dispose of 55-Gallon Drum, Clean up Hours per Shift, Sludge Disposal Cost
OTHER Testing, Training, Liability, Hidden, Environmental, Safety, Health Consideration, Reject/Rework, Credits
TOTAL ANNUAL COST The sum of Applied Material, Energy, Equipment, Labor & Maintenance, Waste, and Other Costs
TOTAL ANNUAL COST PER SQUARE FOOT

The Coatings Guide Cost Tool calculates different categories of costs to come up with a total annual cost per square foot. Each cost category total depends on many variables. Most coatings users will have data to input for each variable. If not, users can rely on default data provided by the tool.

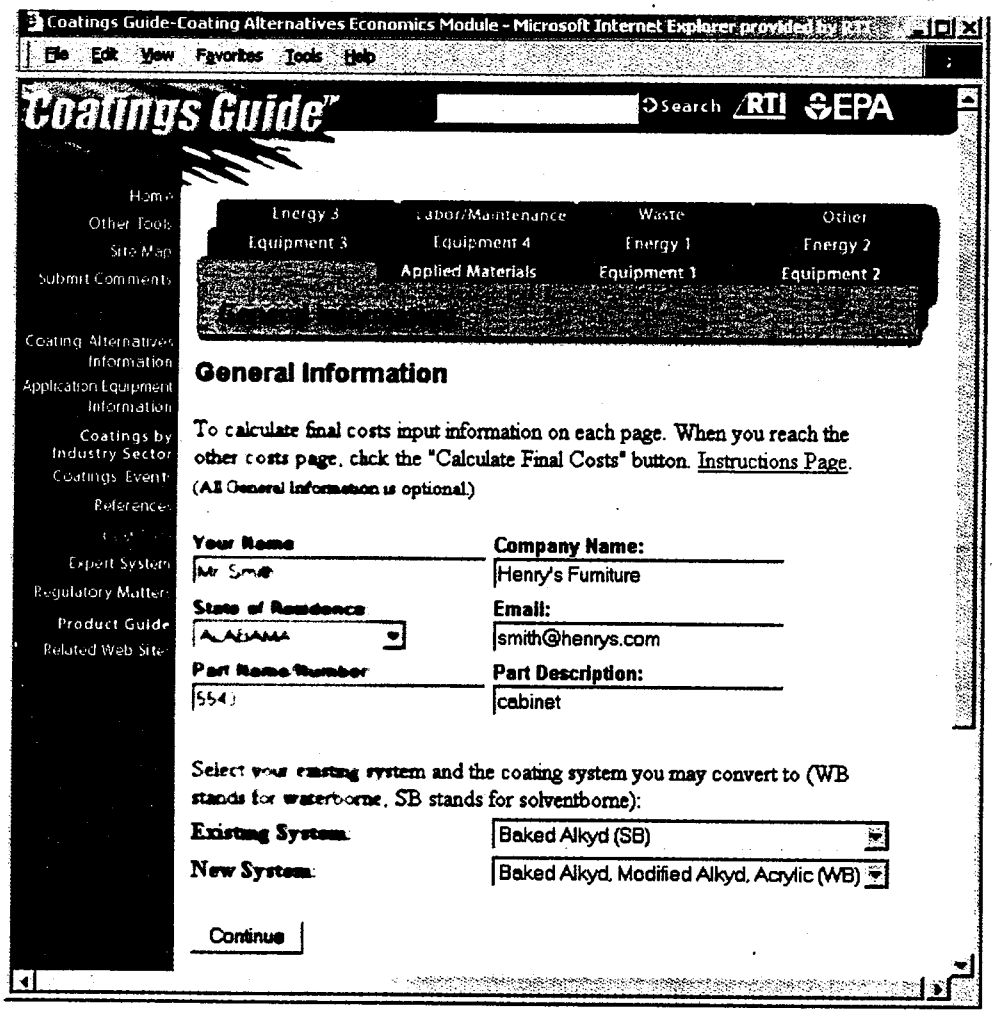
The Cost Tool is easy to use, and Table 3 describes the steps involved. See Figure 2 for an example of the first page of the Cost Tool. A simple tab system leads the user through the tool to a final page, which calculates total annual costs per square foot for comparison of coating systems. If a user does not understand one of the required inputs, pop-up definitions are available with one mouse click. In addition, each page of calculations can be printed, so companies can discuss the results in planning meetings.

Table 3. User progression through the Coatings Guide Cost Tool.

1. SELECT THE COATINGS OF INTEREST Users select their current coating system and the system they are considering switching to from a list of 22 coating types.
2. ENTER CUSTOM DATA OR ACCEPT DEFAULTS Each screen enables users to input custom values or accept defaults. For example, in the Energy Cost input screens, users can input an efficiency rate and price per Btu for their particular region and process, or accept the average values that the tool offers as defaults.
3. CALCULATE FINAL COSTS After entering information, users calculate final costs, which itemize annual costs into materials, equipment, energy, labor and maintenance, waste and other costs. The tool displays total annual costs, as well as cost per square foot coated.
4. USE POP-UP DEFINITIONS FOR HELP Pop-up definitions help users understand what to enter for each input.

Although other cost models exclude equipment costs and nontraditional costs from final cost calculations, or lump them into general overhead costs, the Cost Tool addresses equipment costs in detail, as well as other costs such as testing, training, and health and safety. The following example shows how a company can use the Cost Tool in environmental decision-making.

Figure 2. The Cost Tool is user-friendly and helpful. After selecting a current coating and a possible future coating, a user enters information and calculates final costs. If additional information is needed, users can use default values or pop-up definitions for assistance.



THE EXAMPLE SCENARIO

Henry's Furniture[7]

This example focuses on the use of the Coatings Guide Cost Tool to analyze an alternative topcoat for the low-solids, solvent-borne baked alkyd that is currently used by Henry's Furniture Company,[6] a fictitious company with a realistic coating operation that manufactures high-end desks, credenzas, and filing cabinets. The company employs 350 factory workers, 25 of whom work in the finishing department. The company produces 600 pieces per day, of varying sizes. It operates two 8-hour shifts per day to maintain this production rate. For the most part, the pieces to be coated are cold-rolled, oiled steel. The company has high quality control (QC) expectations, because its customers are willing to pay for high-quality products. As part of these expectations critical to maintaining sales, color and color consistency are important, as are coating appearance and final film performance.

The first step of the production line is de-greasing to remove oils from the substrate. This is followed by a five-stage iron phosphate pretreatment system. Next, pieces are conveyed to the first primer spray booth where a low-solids, solvent-borne polyester baking primer is applied by an automated electrostatic disk to all flat pieces to a 1.0 mil (0.001 in., 0.003 cm) dry film thickness (DFT). A second primer spray booth follows, where the operator uses an electrostatic manual spray gun to touch up areas missed by the electrostatic disk. The primed parts then enter a combination convection with infrared bake oven to cure the primer at 350° F (177° C) for 25 minutes.

After leaving the primer bake oven and cooling to near ambient temperature, the primed parts enter a topcoat spray booth to receive a coat of color polyester baking enamel, a low-solids, solvent-borne baked alkyd. Electrostatic bells are used to apply the first color coat. In a second paint spray booth, the operator uses an electrostatic hand gun to apply the second color coat. The target of 1.2 mils (0.003 cm) DFT is required for topcoat thickness. Top-coated parts are conveyed to a second (topcoat) convection oven where the coating is cured at 350° F (177° C) for 15 minutes. Topcoat color changes occur frequently during the day, especially when special colors are required. The company uses 4 standard and 15 special topcoat colors.

After cooling, the parts are offloaded from the conveyor and assembled into finished products. Approximately 24 hours after assembly, the finished products are packaged and shipped to customers.

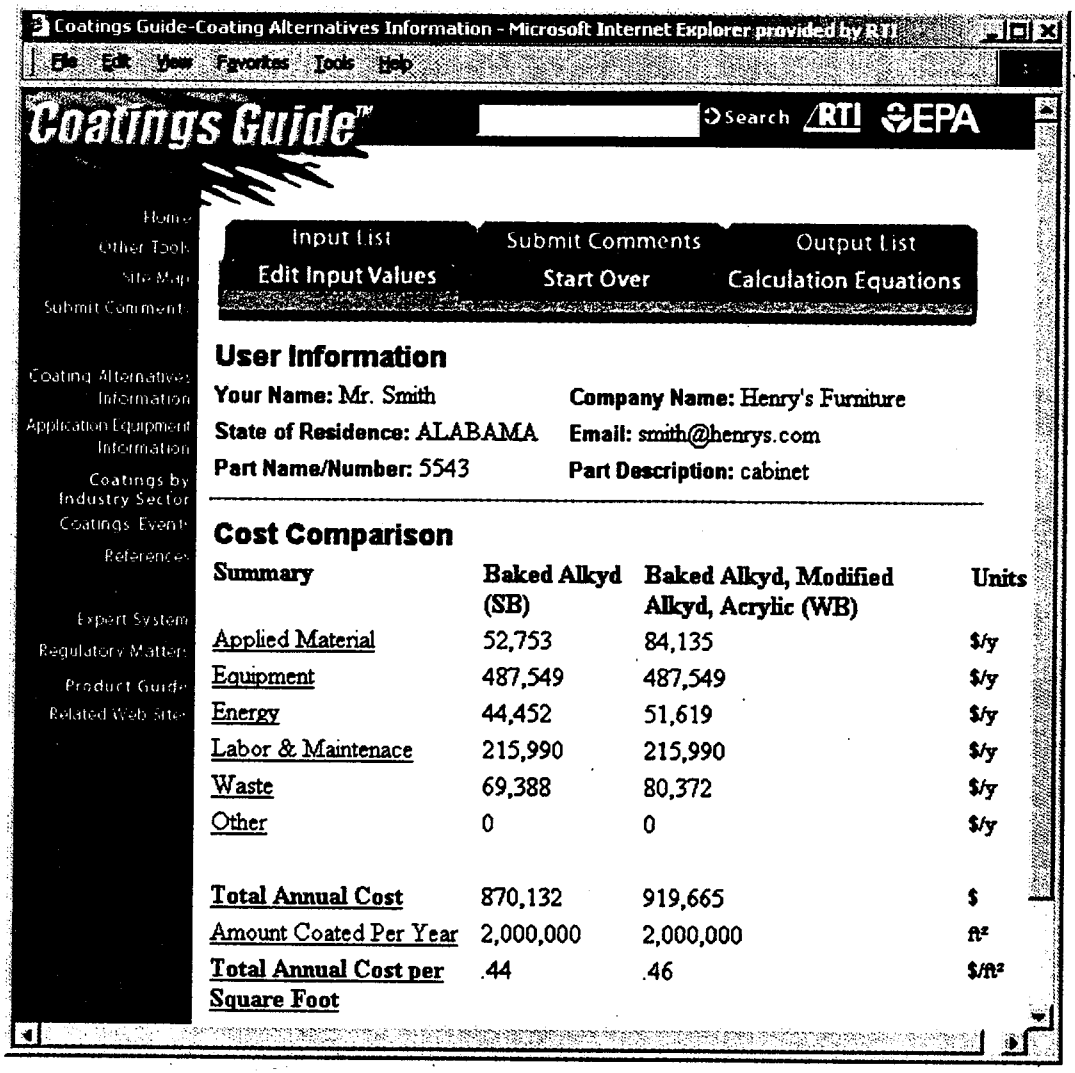
Application of the Cost Tool

In the Henry's Furniture example, the Cost Tool was used to compare costs involved in replacing the solvent-borne baked alkyd with a water-borne baked alkyd. After selecting the solvent-borne alkyd as the existing system and the water-borne alkyd as the new system (see Figure 2), Henry's proceeded to the applied material costs screen. On this screen, the company provided the cost per gallon for the solvent-borne and the water-borne coatings, as well as the correct dry film thickness, production rate, and application system. For other inputs, including transfer efficiency, the company accepted the default values provided by the Cost Tool.

Henry's went through the same process for each Cost Tool category, at times accepting default values and at times changing the numbers. For instance, Henry's accepted most of the defaults for the equipment costs, because it was not considering changing or upgrading its equipment. For energy costs, the bake temperature was increased to accommodate the water-borne coating, but all other defaults were accepted.

After moving through each Cost Tool screen, Henry's came to the cost comparison summary (see Figure 3). The Cost Tool calculated that the water-borne coating was slightly more expensive per square foot to apply. The total annual cost per square foot was 1 to 2 cents more for the water-borne alkyd than the solvent-borne alkyd. To understand the difference, Henry's looked at the itemized cost categories. Although equipment, energy, labor and maintenance, and other costs remained nearly equal between the solvent-borne and the water-borne coatings, applied material costs and waste costs were slightly higher for the water-borne coating. It makes sense that the cost comparison summary showed differences only in applied material and waste costs considering the company was prepared to change only the coating type, and did not plan to make changes in equipment or energy usage. In Henry's case, the raw material cost per gallon of the water-borne coating was slightly higher than the solvent-borne, but that may not be the case for many other scenarios. On the whole, the water-borne coating could be a cheaper option depending on its performance properties, maintenance schedule, and other properties.

Figure 3. The Cost Tool Cost Comparison screen, which shows the final costs for applied material, equipment, energy, labor and maintenance, waste, and other costs.



DISCUSSION

The Cost Tool helps companies such as Henry's Furniture evaluate the relative differences between its current and new coating systems. Built-in flexibility enables users to personalize their input by selecting from 22 coating types. Input is also personalized when users replace the default values with the numbers applicable to their own operation. The accuracy of the Cost Tool largely depends on the accuracy of the inputs, but can be used to identify relative differences in costs between coating systems.

In the example of Henry's Furniture, the Cost Tool was used to compare the costs of a solvent-borne coating to a water-borne coating with similar equipment setups. The Cost Tool could be helpful in analyzing several choices of water-borne coatings to replace the solvent-borne. In a more dramatic example, the Cost Tool could compare a solvent-borne technology to a powder technology, which may involve more drastic changes in equipment costs, energy costs, and other costs.

Development Methodology

To create the cost model behind the Process Conversions Tool, Research Triangle Institute (RTI) posted a voluntary Web survey on the Coatings Guide site to determine what type of model would be most helpful to users. Next, RTI reviewed the literature, including existing cost models, industry publications, and engineering manuals, to establish process equations for costs. When the main costs and equations were identified, RTI contacted coatings associations, manufacturers, equipment vendors, and end-users to find appropriate default values for each cost type. After several comment sessions, the conversion tool was released to the public.

Other Coatings Guide Tools

The Cost Tool is only one feature of the Coating Alternatives Guide (CAGE) Internet Web site, an online resource for businesses. The Coatings Guide is built on a substantial history of information from industry journals, expert advice, and scientific research.

An Expert System helps users determine the best drop-in coating alternatives for their particular processes. Based on answers to a series of questions about part specifications and application methods, users receive a relative ranking of coating alternatives selected for their specific situation.

The Coatings Alternatives Information section summarizes information on more than 30 generic coating types, including radiation-curable coatings. For each coating type, users can find information about surface preparation, application methods, process considerations, performance, and safety/environmental issues. Online information is a summary of information from various coatings journals, trade publications, engineering manuals, and expert advice.

Coatings by Industry Sector is an Internet tool created to support new source review permit writers. The finder provides information on VOC and hazardous air pollutant emissions associated with a range of commercially available coating technologies. Permit applicants and permit writers can use the finder to evaluate non-control options for reducing emissions from new or modified sources.

The Product Guide features lists of low-emitting coatings available from vendors. Users can search for coating chemistries by producer's name, coating type, or VOC content. In addition, users will be able to hyperlink directly to a manufacturer's contact name and number.

CONCLUSIONS

The Coatings Guide Cost Tool is an interactive Web-based tool that can be used as an aid in environmental decision-making, such as P2 decisions. The Cost Tool helps companies in the paint and coatings industry explore the costs involved in switching to low-emitting coatings. The Cost Tool can save time for companies looking into cost issues by educating them about important cost categories and the specific variables required to calculate costs. In addition, the Cost Tool can be used to evaluate multiple alternative scenarios before contacting equipment or coating suppliers.

ACKNOWLEDGMENTS

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KEY WORDS

Pollution Prevention
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Paint
Economics
Cost-Benefit Analysis
Environmental Decision-Making
Total Cost Accounting